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MEMORANDUM

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Date:	20 July 2023
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Mine Waste Management Limited (MWM) has completed this site visit summary memorandum for Santana Minerals Limited (Santana) for the proposed Bendigo-Ophir Gold Project (the Project). MWM has been engaged to provide environmental geochemistry advice for the project to support an assessment of environmental effects (AEE) for the Project.

The objectives of this memorandum are to:

- Summarise findings from a 2-day site visit.
- Develop a preliminary conceptual site model (CSM) for the project, with a focus on potential Acid and Metalliferous Drainage (AMD) hazards.
- Identify important knowledge gaps and make recommendations to fill them.

BACKGROUND

Santana is planning to advance their Bendigo-Ophir Project (the Project) into an operational gold mine. The Project is located approximately 10 km north-east of Cromwell in the Dunstan Mountain Range (Figure 1 & Figure 2).

Santana has agreements with Bendigo Station Limited (BSL) and Ardgour Station (ASL), the landowners of freehold land that covers the main prospects. A comprehensive exploration access arrangement with LINZ (Crown) and Matakanui Station (occupiers) is held over leasehold land to the south of Bendigo Station. Minimum impact access (MIA) agreements for non-mechanical geological and geochemical exploration have been reached with owners of freehold land and the Department of Conservation (DOC) stewardship land over the other prospects within the Project Area (Bunting and McLauchlan, 2022).

Figure 1: Location map showing proposed mine project areas.

Figure 2: General terrain and vegetation on site. Looking northwest over the Jean Creek Catchment towards the township of Hawea.

PROJECT DESCIRPTION

Bendigo-Ophir mineral resource covers 251 square kilometres in the Central Otago goldfields and has a resource estimate of 3 Moz gold @ 1.9g/t (0.25 g/t Au lower cut-off grade, no top-cut), which is based on drill results to December 2022[1]. The Bendigo-Ophir resources occur in 4 deposits (Come in Time (CIT), Rise and Shine (RAS), Shreks (SHR), Shreks SE (SRE) that are inferred to extend in a northerly direction within the Rise and Shine Shear Zone (RSSZ), which hosts gold mineralization over a recognised strike length of >20 km.

The mine plan for the Project, focusing on RAS is still advancing. For the purposes of this assessment, it is assumed to include the following components (Figure 1):

- An open pit, targeting the Rise and Shine deposit.
- A waste rock storage facility (WRS) / engineered landform (ELF) with an associated retention pond.
- Plant and processing area, where CIL/CIP[2] extraction technologies may be used as part of the ore recovery process.

[1] Santana Minerals. https://santanaminerals.com/asset/bendigo-ophir-project-new-zealand/. As at 12 June 2023.
[2] CIL/CIP = carbon-in-leach and carbon-in-pulp processes that uses cyanide as the lixiviant.

- A tailings storage facility (TSF) with an associated seepage collection system.
- And other ancillary support services / structures (e.g., roads, water management infrastructure, etc)

Additional deposits (i.e., Come in Time, Shreks, Shreks SE) may be developed as part of future mine plans. A final decision has not been made on whether to proceed with these deposits.

ENVIRONMENTAL SETTING

Climate

Climate data is available for nearby weather stations (Figure 3), with average annual rainfall in the area between 390 and 550 mm (Table 1). Late winter and early spring rainfall can be about 30 mm per month. Median summer air temperatures for the area are 16–17 °C and winter median temperatures are 5-6 °C. The Project has two weather stations[3], located at Come in Time (CIT) and the other at Rise and Shine (RAS). Measurements at Rise and Shine have been occurring since November 2022.

Table 1: Regional rainfall.

Station	From	To	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Tarras	1951	1980	45	35	49	39	46	31	29	36	38	41	41	42	472
Bendigo 1	1951	1980	41	32	47	39	44	32	25	31	38	42	35	40	446
Bendigo 2	1981	2010	39	32	45	28	31	35	31	26	18	35	29	43	390
Matakanui	1951	2020	58	46	50	46	41	37	31	29	36	51	49	61	535
Cromwell	1981	2010	48	33	43	33	33	38	28	27	26	36	41	52	437

Source: http://cliflo.niwa.co.nz/

[3] Personal communications. H McLauchlan. 26th April 2023.

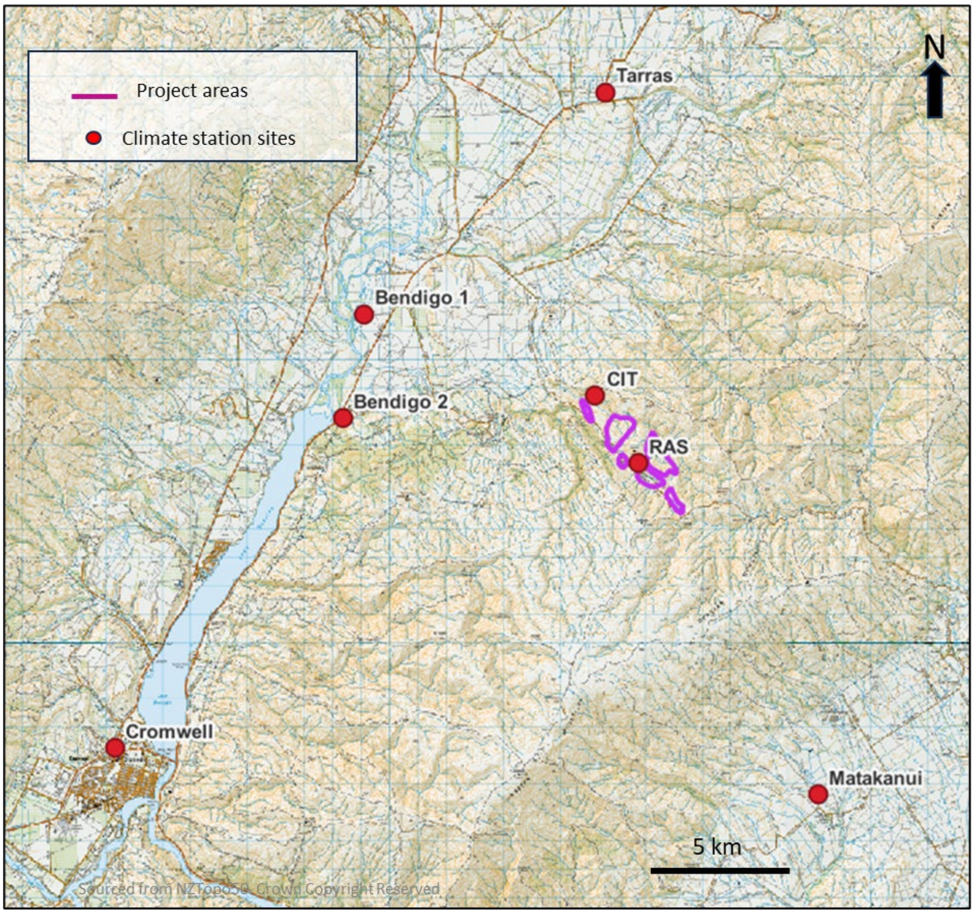

Figure 3: Location of climate stations.

Source: http://cliflo.niwa.co.nz/ and Santana.

Geology

The regional geology of Central Otago goldfields surrounding the Project consists of chlorite and biotite schists. RSSZ, a late metamorphic deformation zone (Cox et al., 2006), runs through the project area. The RSSZ occurs only in the footwall TZ4[4] schist beneath the Thomsons Gorge Fault, which cuts and truncates the Rise & Shine Shear Zone against unmineralised TZ3[5] schist (Cox et al., 2006). There is no gold associated with the Thomsons Gorge Fault itself and gold mineralisation in this area had ceased by the time of formation of the Thomsons Gorge Fault (c. 100 Ma) (Cox et al., 2006).

The hanging wall consists of the TZ3 chlorite zone greenschist facies, and the footwall is the TZ4 garnet-biotite-albite greenschist facies (Mortimer, 2000; Turnbull, 2000). Previous studies in the project area indicated most mineralisation was identified in TZ4 zone, including pyrite, arsenopyrite, and gold (Cox et al., 2006). TZ3 schist has low or zero mineralisation. Field observations by Santana[3] note that the fault zone is a visual boundary in core samples indicated by significant lithological changes in the RSSZ above TZ4. Santana noted that TZ3 is higher in carbon compared to TZ4 (LECO testing in progress to confirm)[3].

[4] TZ4 = Textural Zone 4
[5] TZ3 = Textural Zone 3

Waterways

The project area covers several catchments and sub-catchments, including (Figure 4):

- Shepherds Creek: This creek runs through the project area and runs intermittently towards the Lindis River. An irrigation water-take on Shepherds Creek (RM17.301.15) downstream of SC1 monitoring site takes all available surface water in normal flow conditions, which is supplied to an irrigation dam, so the creek does not flow past this point. There is potential for groundwater to flow past this point via a thin layer of alluvial gravels along the creek bed. This has not been investigated yet. The proposed RAS Pit may straddle this stream.
- Jean Creek: This creek is an intermittent tributary to Shepherds Creek. The proposed WRS / ELF may straddle this catchment.
- Rise and Shine Creek: This creek reek joins Clearwater Creek just South East of the Come in Time Battery and flows into Bendigo Creek.
- Clearwater Creek: Flows into Bendigo Creek.
- Bendigo Creek: Several irrigation water-takes are in place on this creek (RM20.079.01 and RM20.079.02)[6].

A detailed freshwater ecological assessment was undertaken by E3 (2023) and contains freshwater hydrology and more details on the resource consents.

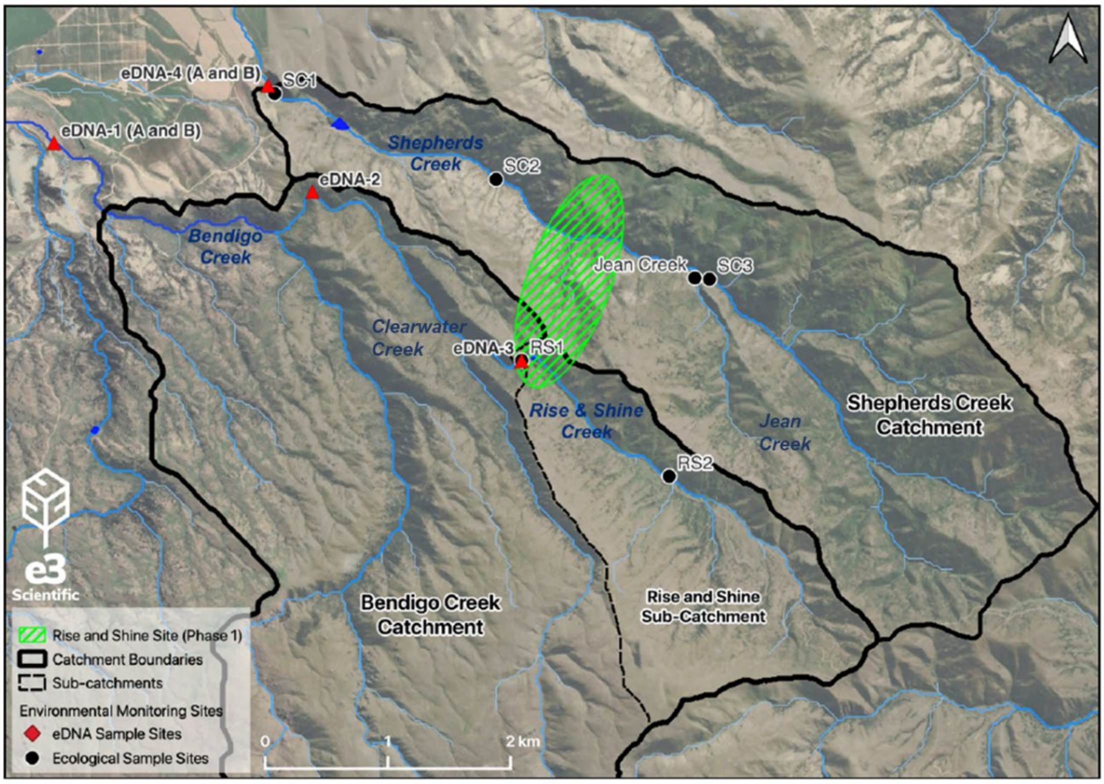

Figure 4: Surface water catchments and monitoring sites.

Source: E3, 2023: Figure 6.

[6] Resource consents granted by Otago Regional Council

Historical Mine Workings

There are numerous historic mine workings throughout the project area, which may have the potential to impact baseline conditions (soils and water). Figure 5 provides an indication of the spatial extent of these historic workings. The archaeological survey completed by Lawrence et al. (2019) indicated 59 historic mine archaeological sites were identified within a 16 km^2 survey area. The majority of mine workings were pre-1900 mining activities (Lawrence et al., 2019) and included the following key historic workings:

- Stamping batteries and processing areas;
- Underground mine adits;
- Mullock piles;
- Tailings mounds; and
- Sluicing areas.

These workings will require the following considerations for any disturbance associated with future mining activities and from a water quality perspective:

- The mine sites and associated workings are considered HAIL[7] sites under the Resource Management (National Environmental Standard for Assessing and Managing Contaminants in Soil to Protect Human Health) Regulations 2011 (NESCS). As such, disturbance of these sites may require contaminated land assessments and management plans.
- The historic workings are likely influencing baseline water quality. Understanding these impacts will be important for ensuring differentiation of load sources from the Project and from these historic sources.

Data and information are not currently available to assess either of these aspects. Further work will be required to address this knowledge gap.

[7] Hazardous Activities and Industries List (HAIL). https://environment.govt.nz/publications/hazardous-activities-and-industries-list-hail/

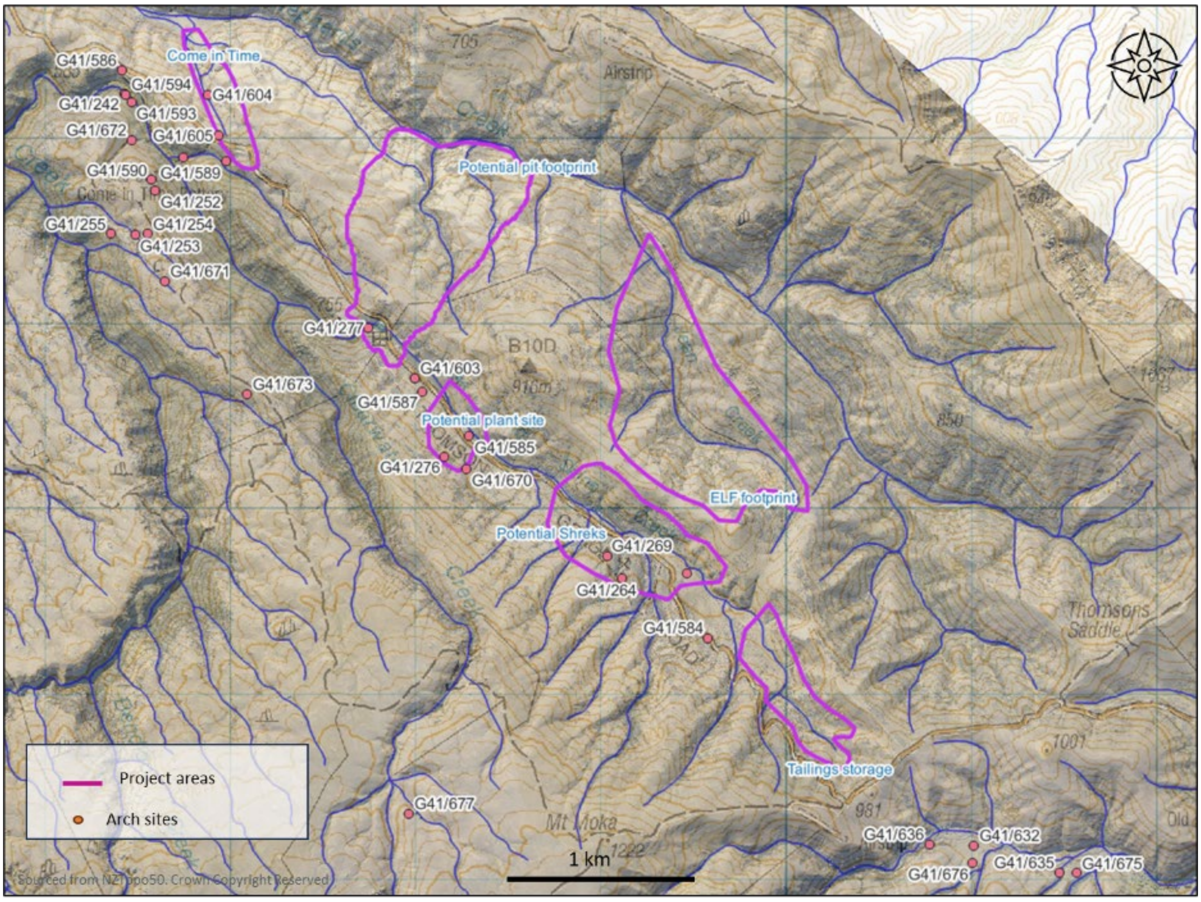

Figure 5: Location of archaeological sites related to mining activities.

Source: Lawrence et al., 2019.

WATER MONITORING

Surface water sites have been established to provide baseline information and understand future mining impacts on the catchments (E3, 2022). The sites are shown in Figure 6 and in Table 2.

Four weirs have been installed for the project to provide accurate flow at medium and low flow conditions at the following water sampling sites:

- SC1
- SC2
- RS1
- RS2

An additional weir site has been installed at Jean Creek since the site visit[8].

Freshwater ecology has been identified as a potentially important sensitive receptor for the proposed mining activities[9], which can be affected by mine-impacted waters.

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[8] Personal communications. H McLauchlan. 20th July 2023.

[9] Note: MWM are not experts in ecological assessments and can only comment on the water quality and geochemical impacts of the project.

Baseline ecological monitoring undertaken by E3 (2023) included passive eDNA sampling; freshwater survey flora and fauna; electric fishing; macroinvertebrate at Bendigo Creek (2 sites) and Shepherds Creek (4 sites); and fish passage assessment (Figure 4).

Table 2: Water quality sampling sites.

Drainage	Site ID	Description	Easting	Northing
Shepherds Creek	SC1	Shepherds at Bendigo Terrace. Downstream monitoring site.	1315697	5019155
	SC2	Shepherds below Come in Time. Intermediate downstream site.	1317451	5018499
	SC3	Shepherds below Rise and Shine. Just upstream from Jeans Creek confluence. Immediately downstream of the proposed WRS.	1319246	5017638
	Jean Creek	An intermittent tributary to Shepherds Creek	1319127	5017648
Bendigo Creek	RSA1	Rise and Shine Adit. Historic workings influence.	1317903	5016873
	RS1	Immediate downstream of the Rise and Shine workings.	1317713	5016973
	RS2	Rise and Shine Creek above Rise and Shine Site. Upstream baseline.	1318918	5016027
Groundwater	MRC002	Groundwater from drillhole at the potential plant location	1318777	5016052
	MDD015	Drillhole within the potential pit footprint.	1318096	5017476
	Base (from water supply)	At the downstream base. Example of water supply.	1310587	5019308

Source: E3 (2023) and Santana.

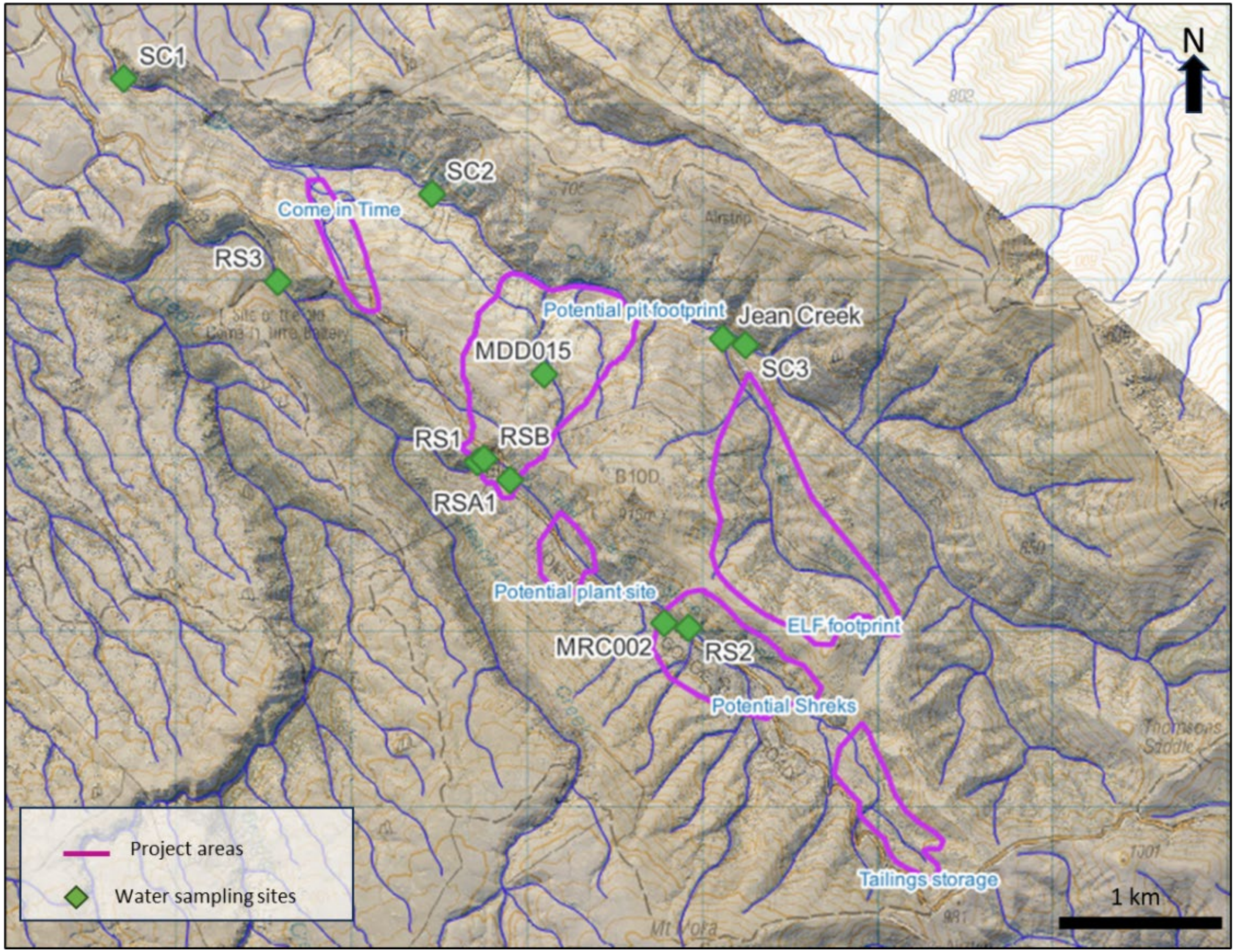

Figure 6: Water sampling sites.

SITE VISIT

A site visit was undertaken between 26 – 27 April 2023 to assess the project area to support water quality and quantity studies, geochemistry studies, and contaminated (mine) site studies.

The site visit focused on:

- Visiting historic mine workings to identify potential source hazards.
- Collecting opportunistic water samples for preliminary assessment of water quality downstream of historic workings.

Field observations and sampling results are described further below.

Historic Mine Workings

The main historic mining sites within the project area visited during the site visit are the Come in Time (CIT) Battery, at the northwest end of the project area, and Rise and Shine (RAS) Battery. A walkover of these sites allowed for observations of potential source hazards and an understanding of the sites to plan future sampling.

CIT Battery (G41/251), associated adits, and mine workings are located at the downstream end of the Rise and Shine Creek and Clearwater Creek (Figure 8). It is located on the southern extent of the project area and borders the Department of Conservation Land that holds the Alta Battery. The CIT mine has a history of repeated operations and closure, being sold to various owners from the mid-1880s until the 1930s (Lawrence et al., 2019). The site had a 10-stamper battery (Figure 8), two adits, ore bins and mullock piles representing the heritage fabric (Lawrence et al., 2019). These are still evident during the site walkover and can provide information to delineate areas of contamination during future site assessments. A large mullock pile occurs out in front and down slope of the red drives (Figure 8). The mullock pile could provide beneficial geochemical information on long term weathering of the waste rock.

Figure 7: Come in Time (CIT) Battery.

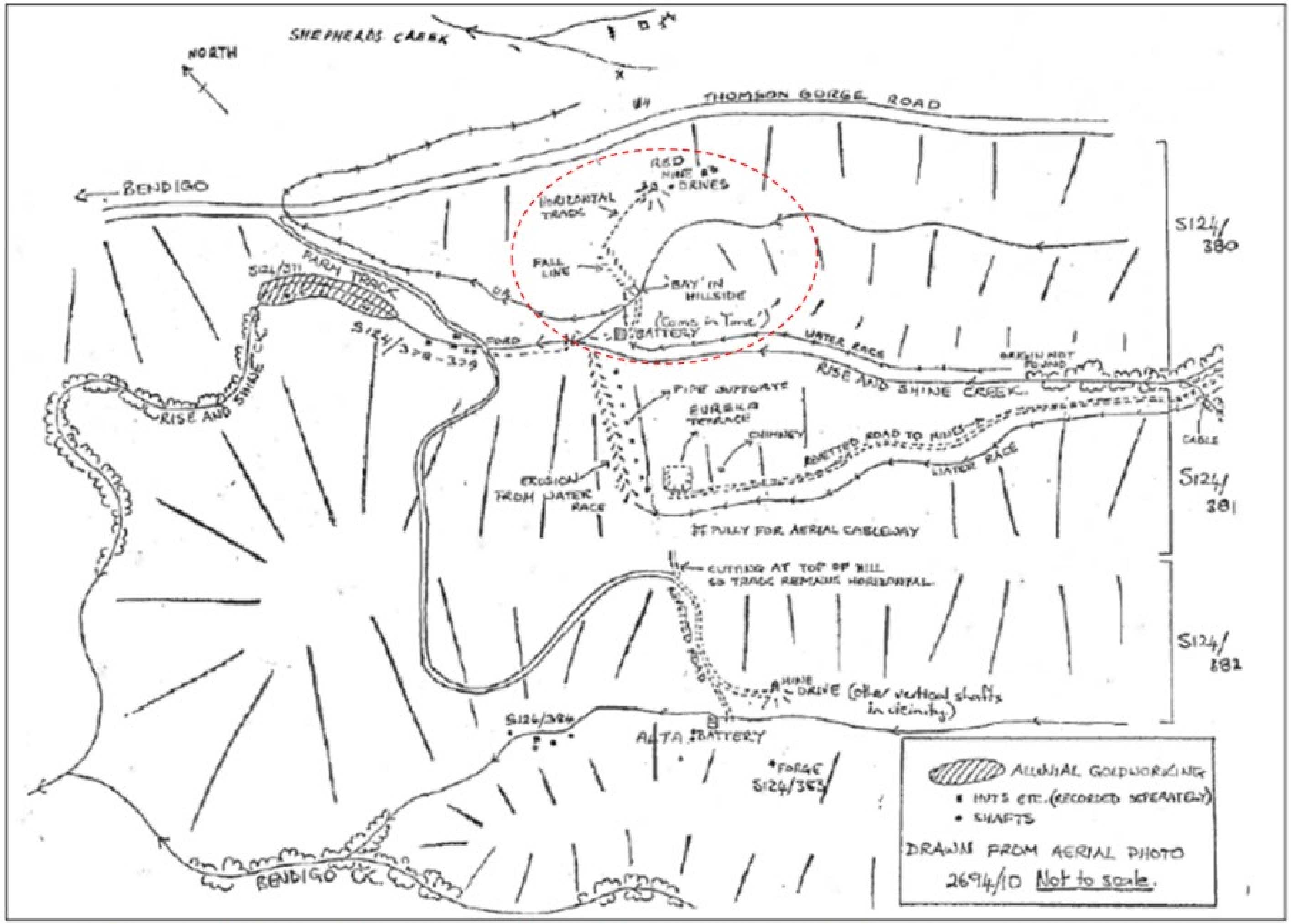

Figure 8-32 Plan of Alta battery (G41/253), Eureka mine and battery (G41/252) and Rise and Shine mine and battery (G41/277) (Hamel, 1993: Figure 19)

Figure 8: Plan of CIT (red circled area) and Alta Battery.

Source: Lawrence et al., 2019 taken from Hamel, J. (1993).

G41/277 at Rise and Shine (Figure 9) had initial mining from 1872 and was re-opened and re-worked during the 1930s and then again from the 1980s to 2000s (Lawrence et al., 2019). The site walkover showed evidence of battery foundations, tailings and workings scattered around the RAS battery and upstream beside the RAS Creek (Figure 9 and Figure 10). The heritage report (Lawrence et al., 2019) noted that the historic tailings have been disturbed by more modern gold workings likely to be early twentieth century.

In the Rise and Shine Creek, in front of the battery site, there was evidence of iron rich precipitates that could indicate seepage of AMD off the processing site. It was localised to an approximately 4 m by 4 m area. A grab water sampling was taken from this site (water monitoring site RSB: see Figure 6) to assess the water quality.

At G41/264 gold mining workings were associated with the 1860s mining activities, including tailings mounds and sluicing activities. The area has been reworked in modern times with evidence of trenching, pitting and drillholes mid-1980s to 20th century (Lawrence et al., 2019) and tailings being spread up to 160 m along the valley floor (Figure 10). Throughout the area, rock walls, mullock piles, and tailings were evident, as well as adits and wetlands in depressions that could have been prospecting pits. These workings are elluvial sluice workings. It is assumed that these materials are likely to have minor, if not less than minor, effects on water quality.

Santana staff were on site with a portable XRF. Qualitative spot testing of a rock sample from RAS with iron veining (Figure 11) indicated As concentrations of ~5,553 ppm compared to the rock without veining that was measured at ~ 200-280 ppm. Arsenic strongly adsorbs to Fe hydroxides and results confirm As mineralisation in the area and association with the ore zones.

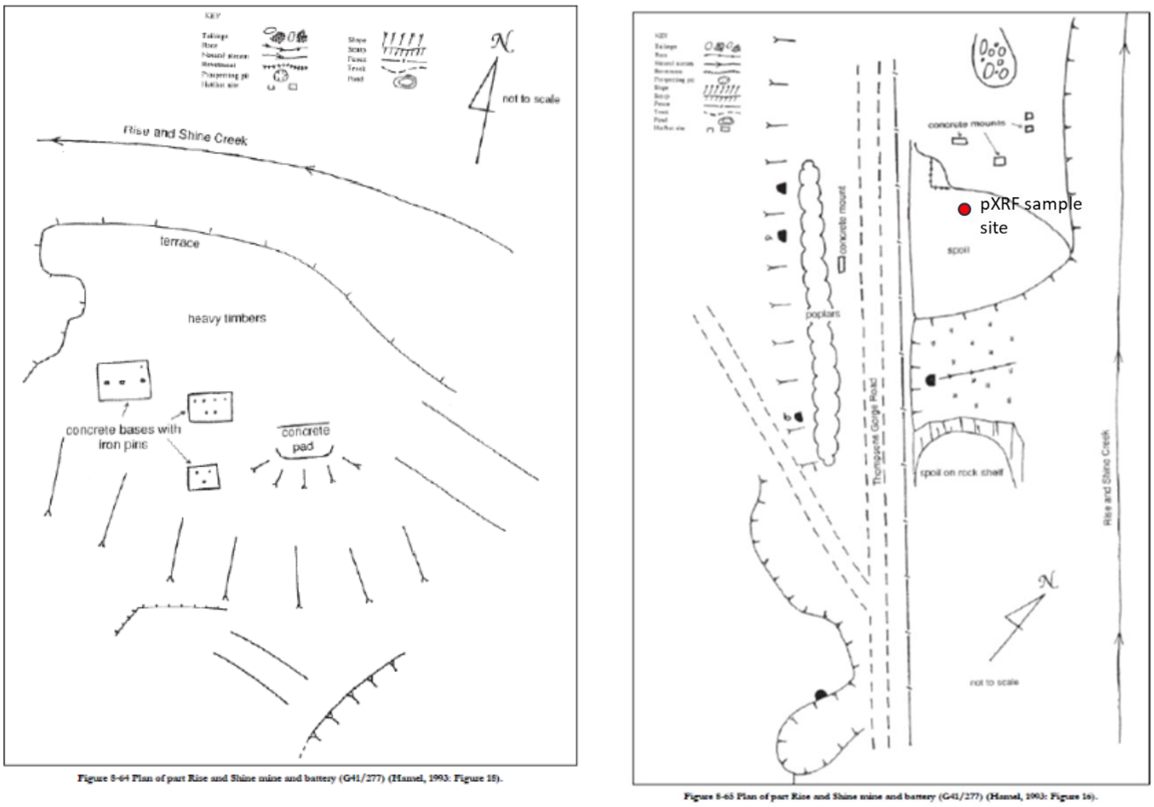

Figure 9: Plans of the Rise and Shine Battery and associated historic workings.

Source: Lawrence et al., 2019 taken from Hamel, J. (1993).

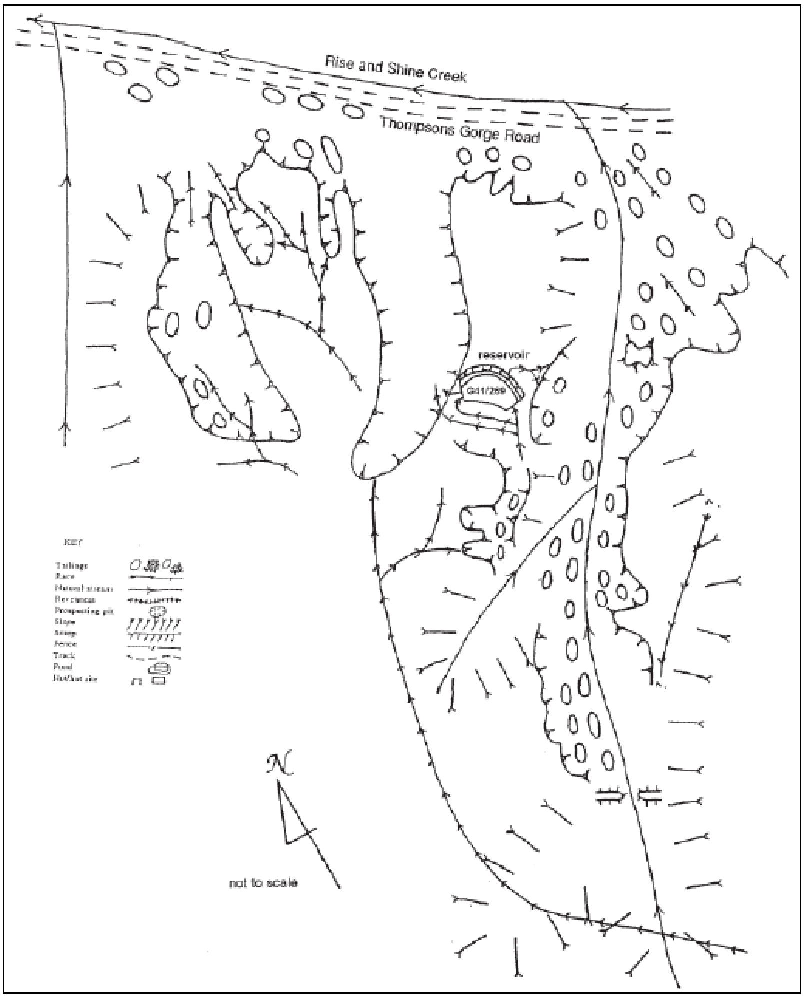

Figure 8-90 Plan of part of alluvial workings (G41/264) and dam (G41/269) developed from Hamel's (1991: Figure 12 in Nichol and Wright 2006: Figure 10).

Figure 10: Plans of the elluvial workings southeast and upstream of Rise and Shine Battery.

Source: Lawrence et al., 2019 taken from Hamel, J. (1993).

Figure 11. Fe-rich rock sample from the RAS Spoil

See Figure 9 for sample location (pXRF)

Water Sampling

During the site visit on 27 April 2023, a number of the existing water monitoring sites (SC1, Jean Creek, RS2, RSA) were visited to gain an understanding of the site locations, catchment area, and potential source hazards.

Seepage from groundwater into Ferret Gully and into Shepherds Creek was evident down gradient of MDD015.

During the site visit, three opportunistic water grab samples were taken from the following sites:

- MDD015 - a free flowing drillhole at MDD015 (i.e., groundwater) and the adjacent settling pond (Figure 11). This drillhole is situated within the potential pit footprint.
- RSB - adjacent to RAS Battery Site in the Rise and Shine Creek. There was evidence of iron-rich precipitates in the Rise and Shine Creek adjacent to the battery site that may indicate seepage from the battery residue materials (e.g., spent ore) and the deposition of metals within the sediments of the creek. Due to the high sediment content and difficulty in obtaining sufficient clean samples, only total and dissolved metals and field testing was completed.
- RS3 - downstream of CIT Battery and in Clearwater Creek. Monitoring at this location will provide baseline information on the impact of the historic workings on the water quality. In the future, this will provide information on any changes from the project development and to understand the impacts on surface water from the historic mine workings.

Site locations are provided in Figure 6 with additional details provided in Table 3.

No sampling of the soil and rock at the heritage sites was able to be completed due to the need for archaeological authority from Heritage New Zealand Pouhere Taonga (HNZPT).

Table 3: Site visit water quality sampling locations.

Drainage	Site ID	Description	Easting	Northing
Bendigo Creek	RSB	In Rise and Shine Creek adjacent to RAS Battery Site. Provides an indication of the effects of residue material (tailings) from historic workings within the catchment.	1317842	5016985
	RS3	In Clearwater Creek, downstream of the confluence with Rise and Shine Creek. Downstream from CIT Battery and workings. Provides an indication of effects of historic workings within the catchment.	1316573	5017998

Figure 12: Site MDD015 drillhole with free-flowing groundwater.

Field measurements for the samples taken during the site visit are presented in Table 4 with key lab results presented in in Table 5. Water quality results were compared against ANZG default guideline values (DGVs) for 95% species protection. Full results of the water testing are included in Attachment A. Key findings from the sampling programme indicated that:

- pH ranged from 7.46 to 8.43 for the samples assessed.
- The MDD015 sample was above guideline values, for dissolved arsenic.
- The RSB sample was above guideline values for dissolved arsenic, iron, and manganese.

These data suggest that Fe, As, and Mn could be elevated in drainage waters from site and are amongst the key contaminants of concern for the project.

Table 4: Water quality sampling sites - 27 April 2023.

							Field measurements					
Site ID	Sample type	X	Y	Date	Time	Flow (L/min)	pH	EC	Temp	DO	ORP	Comments
								uS/cm	C	%	mV	
MDD0015	GW	1318096	5017476	24/4/23	11:30	3-6 L/min (estimated)	8.01	421.9	11.7	8.7	-121.2	-60 degree west facing drillhole. Water free flowing. Some white precipitates on stones. Smell of hydrogen sulfide around the bore.
MDD015 pond	GW pond	1318096	5017476	24/4/23	11:30	-	8.43	420	9.7	93	-46.5	Pond receiving water from MDD015.
RSB	SW	1317842	5016985	24/4/23	14:00	-	6.71	206.6	10.2	10.3	30.6	Adjacent to Rise and Shine Battery. Water in RS Creek. Full of reeds. Muddy. Iron-rich precipitates. Only sampled metals due to lack of clean water. The site may provide an indicate of effects if there is seepage of contaminants from the spent ore at the battery site.
RS3	SW	1316573	5017998	24/4/23	14:35	-	7.46	71.2	6.7	100.9	25	New site. Clearwater / RS Creek downstream.

Table 5: Select water quality results from sites sampled 27 April 2023.

SITE ID		MDD015	RSB	RS03	ANZG 2018 DGV 95% species protection
pH	pH units	8.2	-	7.4	6.5-8.5
Total Alkalinity	mg $CaCO_3$/L	195	-	36	0
Sulfate	mg/L	16.5	-	1.07	1,000[1]
Nitrate-N	mg/L	<0.01	-	<0.01	0.7
Dissolved metals and metalloids					
Soluble Aluminium	mg/L	0.003	<0.002	0.006	0.055
Soluble Arsenic	mg/L	0.036	0.142	0.009	0.013
Soluble Cobalt	mg/L	<0.0005	<0.0005	<0.0005	0.0014
Soluble Copper	mg/L	<0.0005	<0.0005	<0.0005	0.0014
Soluble Iron	mg/L	<0.01	1.01	0.07	0.3
Soluble Manganese	mg/L	0.0064	2.76	0.0170	1.9
Soluble Zinc	mg/L	<0.002	<0.002	<0.002	0.008
Total Metals and metalloids					
Total Aluminium	mg/L	0.193	1.17	0.012	
Total Arsenic	mg/L	0.035	5.29	0.011	
Total Chromium	mg/L	<0.001	<0.001	<0.001	
Total Cobalt	mg/L	<0.002	0.006	<0.002	
Total Copper	mg/L	<0.002	0.002	<0.002	
Total Iron	mg/L	0.3	86.5	0.1	
Total Manganese	mg/L	0.009	4.40	0.019	
Total Zinc	mg/L	<0.005	0.079	<0.005	

[1] – ANZECC (2000) stock water drinking guidelines. Red data are above guideline values.
Hyphen (-) indicates no data available.

PRELIMINARY SOURCE HAZARD ASSESSMENT

Several source hazards exist:

- Potential AMD source hazards exist due to the mineralised rock containing sulfides, metals, and metalloids that may contribute to AMD. The mine domains that contain these materials (e.g., pits, WRS, low grade ore (LGO) storage, and processing of the ore (i.e., plant and TSF)) may present AMD hazards.
- Materials could also be impacted by nitrogenous compounds such as nitrate and ammoniacal nitrogen due to the use of ammonium-nitrate based explosives. Mine domains that contain blasted materials can therefore be a source hazard for nitrate-impacted drainage.
- Earthworks can disturb significant quantities of materials that can contribute to runoff elevated in total suspended sediment (TSS), which is often a resource consent compliance condition. Sediments can also be elevated in contaminant of concern that can contribute to off-site contamination if not managed in an appropriate manner.

The three hazards described above can be classified as mine-impacted drainage, which can therefore be affected by AMD, nitrate, and TSS.

Basal seepage to groundwater, toe seepage, and surface water runoff from mine domains containing waste materials or where waste materials are exposed (e.g., pit walls) provide a pathway from source hazards to the receiving environment.

Historic mine workings are another source of contaminants that need to be considered.

PRELIMINARY CONCEPTUAL SITE MODEL

A Conceptual Site Model (CSM) needs to be developed for the project. The CSM is also an essential communication tool for risk assessments with internal and internal stakeholders and:

- Supports the process of risk assessment by providing a clear visual guide;
- Facilitates a process for identifying potential risks and data gaps; and
- Provides a structure to develop performance and compliance monitoring programs.

The CSM will inform the Project's environmental geochemical risk profile, indicating potential sources of contamination such as pits and waste landforms, and their connection to potential receptors (e.g., sensitive ecosystems) via pathways such as surface water and groundwater, commonly referred to as a source-pathway-receptor (SPR) framework.

Note that a comprehensive identification of potential pathways and receptors falls outside the scope of this assessment and reflects a current data gap. Based on the site visit and background information, a preliminary CSM has been provided in the discussion below and in diagrammatic form (Figure 12).

Sources

Sources of contamination may include materials such as rock, ore, soil, and water. Disturbance and storage of these materials may result in geochemical change and degradation. This memorandum addresses geochemical contamination sources and excludes physical and biological contaminants.

Sources of contamination are broken down into the following mine domains:

- Open Pit
- Waste Rock Stack
- Tailings Storage Facility
- Mine Plant and Processing Area
- Historic Workings

Baseline conditions may be elevated due to mineralisation and can be another source of contaminants. Baseline conditions need to be assessed as part of project studies.

Sources are described further in the following sub-sections.

Pit

The proposed pit is expected to be south of Shepherds Creek. It is proposed to cut through the Rise and Shine Creek and into the RAS historic workings.

During operations it is anticipated that runoff within the pit shell will contribute to the contaminant load reporting to the pit sump, which will be removed by pumping (dewatering). At the end of operations, a pit lake is likely to form with water quality reflective of the geochemistry of the pit walls and waste rock (if backfilled). The pit lake itself maybe a source hazard at some time post-closure.

Only high-level conceptual information is available for the pit design. The following data gaps are noted that need to be addressed:

- A detailed block model with lithological /material volumes per operational year (including waste rock, waste rock types, ore, LGO).
- Location and detailed design of the pit.
- Understanding of AMD potential for pit wall runoff and explosive residue.

It is recommended, to progress studies, that:

- A cross section be provided through the conceptual pit orientated north – south with drillholes provided and logs to select samples for environmental geochemistry studies.
- Estimated materials quantities be provided to commence sample selection for the environmental geochemistry studies.
- That geochemical testing be developed to generate source terms for the various materials that would influence pit water quality.
- That a source term be developed for nitrate and ammoniacal nitrogen using available literature and industry experience (as this can’t be derived from unblasted drillcore).
- A site wide water balance model needs to be constructed in the future so that contaminant loads can be determined using flows and source terms.

Waste Rock Stack

The WRS (or ELF) is expected to have a seepage capture system and a downgradient retention pond. Potentially a catchment spillway from Jean Creek into Shepherds Creek will be constructed.

Pathways from this mine domain include WRS seepage, WRS runoff, and overflow from down gradient retention pond.

The following data gaps are noted that need to be addressed:

- Determine final location and design of the WRS.
- Determine the waste rock material balance and any lithological / geochemical differences of the waste rock.
- Understand the AMD potential from the oxidation of sulfides contained in mine waste.
- Understand the effects of mine waste rock containing blasting residues (ammoniacal nitrogen).

Tailings Storage Facility

The proposed TSF is likely to contain materials elevated in sulfides (sulfide oxidation products), processing residues (e.g., lime, cyanide, etc), and blasting residues. Pathways from the proposed TSF include process return water; seepage of tailings pore water, and surface runoff from the TSF.

The following data gaps are noted that need to be addressed:

- Confirm the final location and design of the TSF to understand potential pathways (basal and toe seepage).
- Determine the environmental geochemistry risk associated with the tailings material and any embankment materials [noting the environmental geochemistry source hazards can be determined from metallurgical test residues: materials are available]
- Determine the quality of the process water.

Historic Mine Workings

Historic workings can contribute to contaminant loads from mine impacted water, sediment discharge and seepage. It is important to understand baseline conditions to separate historic legacy issues form future project effects. Information from these historic workings can also provide an understanding of the potential environmental impacts of long-term storage of waste rock. Identified source hazards at the historic mine workings include:

- Mine adits.
- Sluicing areas.
- Waste rock and mullock piles.
- Processing areas.
- Tailings.

The following data gaps are noted that need to be addressed:

- Understand AMD potential (water quality and contaminant loads) from historic wastes and adits.
- Understand current insitu contamination (e.g., soils, groundwater, etc.).
- Understand potential for erosion and sediment release.
- Derive source terms from historic materials to include in water quality models. This will require an archaeological authority from HNZPT and permission from DOC to sample materials if they are on Public Conservation Land.

Mine Plant and Processing Area

The location of the processing plant is not yet finalised but may be on the ridge between the pit and WRS or on flat land near Thomson Gorge Road. Regardless of the location, the potential geochemical sources include:

- Process water.
- Treatment chemicals.

- Ore and residue.
- Tailings.

The following data gaps are noted to consider environmental geochemistry risks:

- Information on the plant design and processing operations.
- The location, design and storage of impacted water, rock and ore at the plant and associated sites.

Pathways

Pathways are how contaminants can move into the wider environments from the source hazard to the receptors. The pathways identified for this project associated with environmental geochemistry hazards include:

- Surface water flow, specifically along drainage pathways.
- Groundwater flow through alluvial sediments and bedrock.
- Soil and rock movement.
- Direct human exposure.

Limited information is available to support understanding pathways and further monitoring is required. The following data gaps are noted:

- Long-term site-specific climate records.
- Surface and groundwater quantity and quality variability in time and space.
- Current sampling site locations do not capture the potential impact from all historic mine workings on waterways that the Project has the potential to impact.
- Runoff generation rates for undisturbed catchments.
- Hydrogeological characteristics and conditions of alluvial sediment and bedrock.

Filling these data gaps will be important to understand the Project's risk to the environment, and support future studies (e.g., water quality modelling) that are required for the assessment of environmental effects and water management designs.

Receptors

The receiving environment includes the following:

- Surface water bodies (Jean Creek, Shepherds Creek, Clearwater Creek, Rise and Shine Creek, Bendigo Creek, Clutha and Lindis rivers).
- Ecology (aquatic, terrestrial).
- Groundwater:
    - Domestic groundwater abstraction.

    - Irrigation groundwater abstraction.

- Heritage areas / workers / volunteers / public.
- Project workers and visitors.

A more detailed risk assessment is recommended once additional data and information are collected to improve understanding of sources, pathways, and receptors. Such data can be used to support the site-wide water quality model of the various mine domains and the receiving environment to understand effects and thus risks.

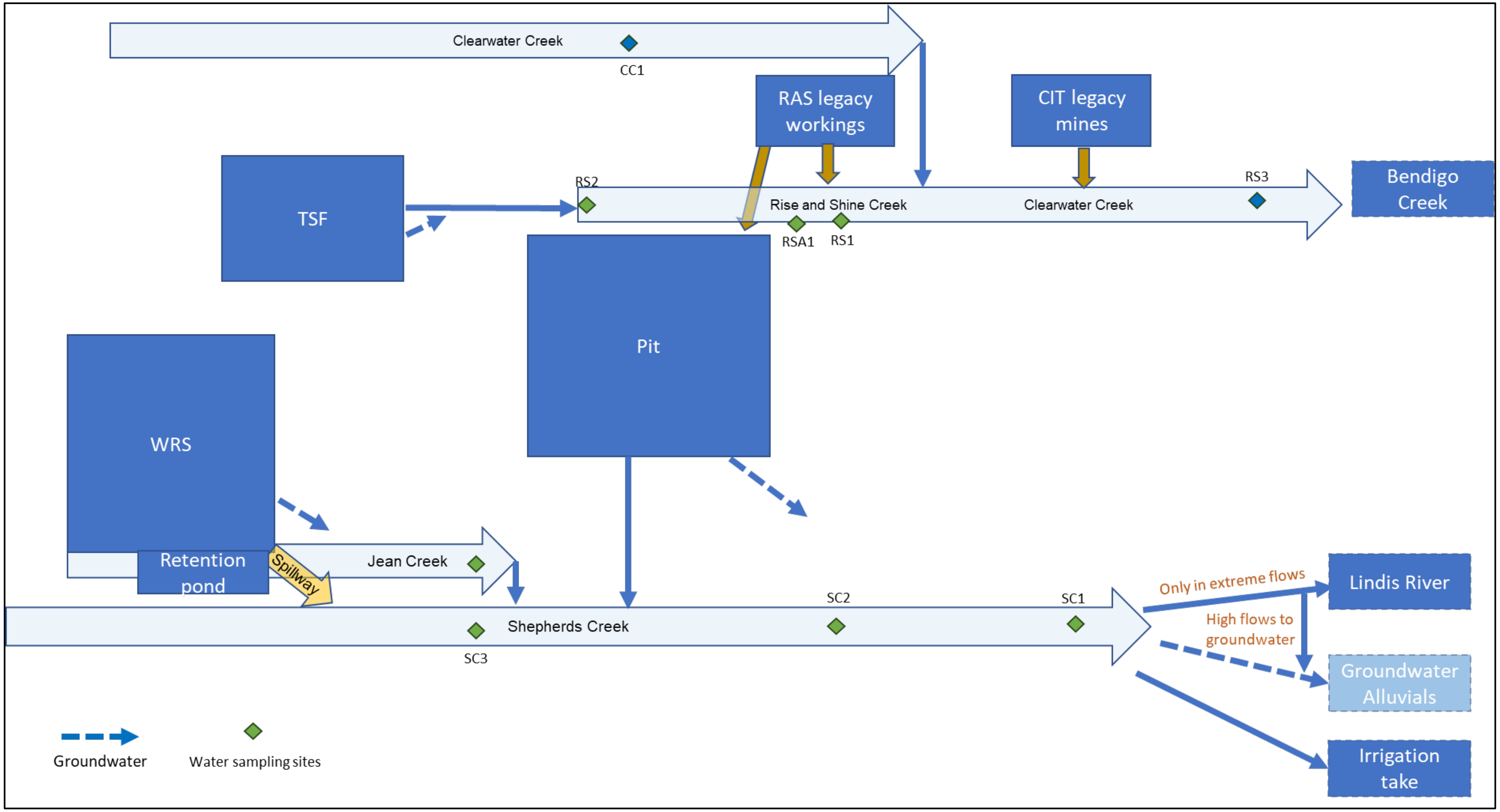

Figure 13: Diagrammatic preliminary CSM.

SUMMARY AND RECOMMENDATIONS

The following summary and recommendations are provided:

Summary

The historic legacy workings will require the following considerations:

- The mine sites and associated workings are considered HAIL[10] sites under the Resource Management (National Environmental Standard for Assessing and Managing Contaminants in Soil to Protect Human Health) Regulations 2011 (NESCS). As such, disturbance of these sites may require contaminated land assessments and management plans. This would include preliminary site investigations (PSI) and detailed site investigation (DSI)
- The material from historic workings are likely influencing baseline water quality. Understanding these impacts will be important for ensuring differentiation of load sources from the Project and from these historic sources.

Data and information are not currently available to assess either of these aspects. Further work will be required to address this knowledge gap.

Data from legacy sites and from current drillhole water suggest contaminants of concern could include As, Fe, Mn. Other contaminants of concern may also be elevated, and further work is required to identify this (which will be addressed by environmental geochemistry studies).

Knowledge Gaps

Discipline specific recommendations to fill identified knowledge gaps are described below.

<u>Geochemistry</u>

Understanding the geological environment of the ore and waste rock units will be important to advance the understanding of the environmental geochemistry hazards associated with the project.

Santana is working on the development of a preliminary pit shell that will provide estimates of waste rock (and waste rock types), mineralised waste, and ore quantities. This knowledge will be important for advancing the CSM including the extent of each mine domain (e.g., pit, waste rock stack, tailings storage facility, LGO stockpile, etc).

The preliminary pit shell material estimate will be important for guiding the sampling and analysis plan for waste rock / ore as well as the conceptual assessment of the potential effects from the various mine domains.

Request for Further Information

The following information is required from Santana:

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[10] Hazardous Activities and Industries List (HAIL). https://environment.govt.nz/publications/hazardous-activities-and-industries-list-hail/

- A long section be provided through the conceptual pit orientated north – south with drillholes provided and logs to select samples for environmental geochemistry studies.
- Estimated materials quantities be provided to commence sample selection for the environmental geochemistry studies.
- Confirm expected final location and design of the WRS.
- Provide the waste rock material balance and any lithological / geochemical differences of the waste rock.
- Confirm the final location and design of the TSF to understand potential pathways (basal and toe seepage).
- Obtain archaeological authorities from HNZPT for disturbance of historic area, as required.
- Obtain access from DOC for any samples on their land with the historic mullock dumps.

Further Studies

Further work is required to constrain and update the preliminary CSM and refine geochemical assessments, as summarised below:

- Chemical and nutrient soil analyses would be useful to inform soil capacity and future remediation potential.
- A source term needs to be developed for nitrate and ammoniacal nitrogen using available literature and industry experience (as this can't be derived from unblasted drillcore).
- Understand the AMD potential from the oxidation of sulfides contained in mine waste.
- Determine the environmental geochemistry risk associated with the tailings material and any embankment materials [noting the environmental geochemistry source hazards can be determined from metallurgical test residues: materials are available]
- Determine the quality of the process water.
- Develop a site wide water balance model needs to be constructed in the future so that contaminant loads can be determined using flows and source terms.

<u>Historical Mine Workings</u>

Further detailed delineation and load contribution from the historic workings are required. This information will inform the CSM and understand the contaminant contribution from these sites. Further work required includes:

Further Studies

A mullock pile (< ~1,000 m^3) occurs in front and down slope of the red drives (Figure 8). The mullock pile could provide beneficial geochemical information on long term weathering of the waste rock. It is important to manage the work around these sites to protect the heritage and archaeological values. Soil and rock sampling will involve the disturbance of the heritage and archaeological sites requiring an archaeological authority from Heritage New Zealand Pouhere Taonga (HNZPT). Santana needs to apply for permits to access these materials.

Other work that needs to be completed includes:

- Compile existing geochemical and contaminant information to identify gaps and provide background on the sites.
- Understand AMD potential (water quality and contaminant loads) from historic wastes and adits.
- Understand current insitu contamination (e.g., soils, groundwater, etc.).
- Understand the potential for erosion and sediment release from historic materials.
- Derive source terms from historic materials to include in water quality models.
- Additional detailed soil testing to supplement existing information, to define the lateral and vertical extent of the sites.
- Water sampling upstream and downstream of the main sites over different flow regimes (similar analytical suite as for waste rock) to understand impacts from the sites on water quality in different seasons.
- Groundwater sampling (e.g., groundwater wells) to understand subsurface contributions from the historical sites may be required following the completion of the DSI.

If historical sites are to be disturbed, then PSI and DSI studies may need to be completed. Resource consents for disturbance of historic mine sites are likely to be required, which includes associated investigations, management plans and remedial plans.

<u>Water Monitoring</u>

Further Studies: Surface Water

The existing surface water monitoring sites in Table 2 include sites downstream of the main mine domains (i.e., contaminant sources). However, as noted in the CSM a small number of gaps were identified. The following recommendations are provided to improve the baseline monitoring program and support future assessments required for the AEE:

- Site RS3 should be incorporated into the baseline monitoring program to monitor for water quality impacts from historic mine workings (e.g., CIT battery) not already captured by existing monitoring sites.
- A site for long term monitoring of baseline in a non-impacted area such as Clearwater Creek (CC1) (Figure 13) or an equivalent site would allow for robust distinction between potential natural changes in flow and water quality related to climate variability, and those from the Project.
- Plan for flow gauging at RS3 to inform contaminant load calculations and provide information for future compliance. This can be completed as part of water quality monitoring. Note that this will also support the development of rating curves which will support other aspects of the Project (e.g., water management designs)
- Frequency of monitoring should be planned to represent seasonal changes and different flow regimes. This is to cover high and low flow conditions. A monthly frequency for surface water is recommended.

- Compile and maintain a monitoring database for all water quantity and quality data to ensure robust dataset are available for future assessments and studies. Experience at many mines has shown that poor data storage and housekeeping leads to data quality issues and additional consultant costs that could have been avoided.
- Assess the data collected after 12 months of monitoring and after geochemistry assessments have confirmed the potential contaminants of concern to identify appropriate modifications to sampling locations and/or lab analysis suits (e.g., reduction in frequency and/or sampling sites where appropriate).

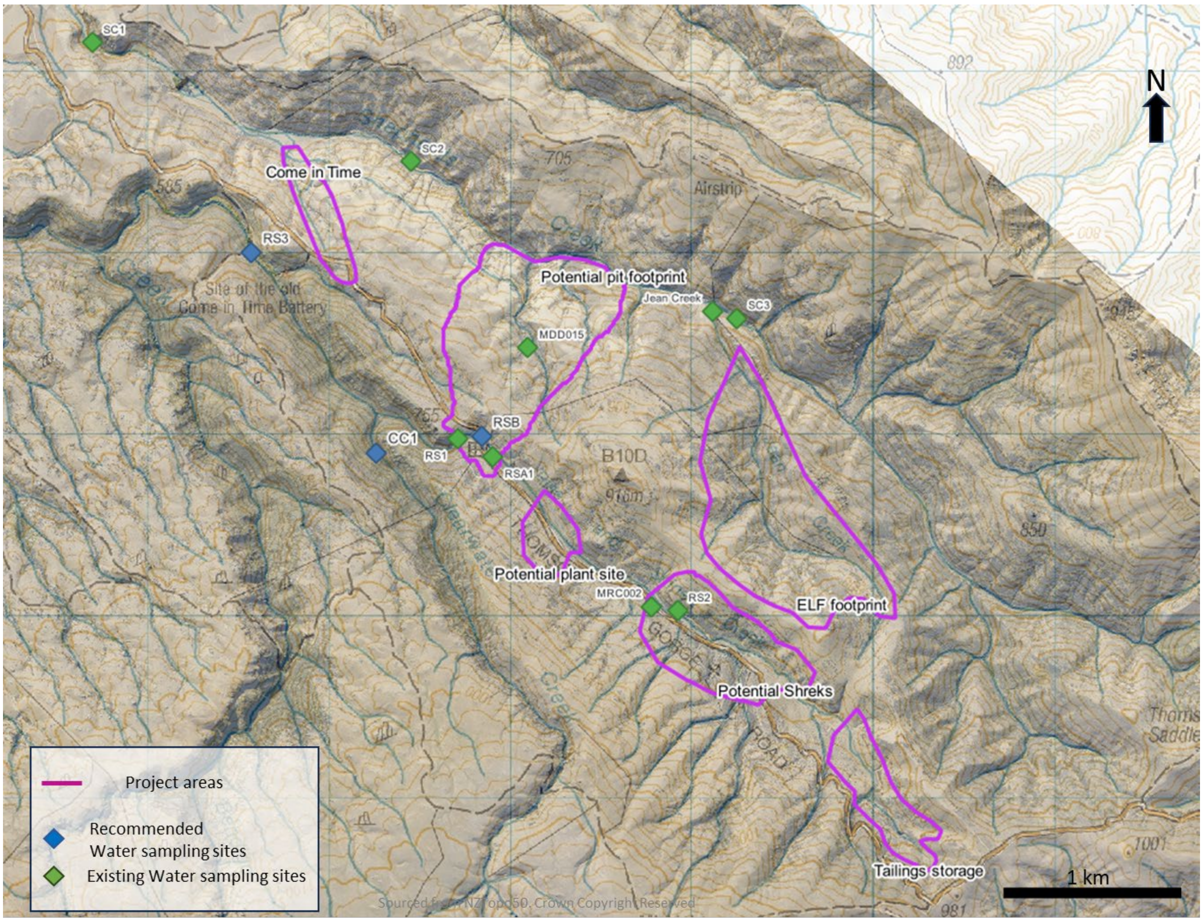

Figure 14: Recommended and existing monitoring sites.

Further Studies: Groundwater

Mine impacted waters entering groundwater has the potential to migrate towards downgradient groundwater users in the Lindis / Clutha River valley. Further studies are recommended to understand this potential risk:

- Santana[11] will undertake necessary work to document the hydrogeological characteristics of the valley bottom sediments of Shepherds Creek and Bendigo Creek to inform the potential for

[11] Personal communications. H McLauchlan. 20th July 2023.

transport of AMD via groundwater along the creek valleys. This will also help support the design of seepage collection systems planned for the TSF and WRS and understand the potential for seepage bypass.

- A groundwater monitoring network should be established to confirm the performance of seepage collection systems and ensure seepage bypass does not become problematic for water quality. Establishing baseline monitoring for groundwater will be required. This monitoring network should be optimised to fulfil groundwater assessment requirements for historical mine workings where possible.
- Investigate the hydrogeological characteristics of the bedrock beneath the site to confirm that bedrock has a low potential for transporting AMD generated by the Project. This may also include considerations for faults (e.g., the Thompson Gorge Fault) to provide preferential pathways for contaminant migration from mine domains (including a pit lake post-closure). This characterisation will also inform estimates of pit dewatering requirements and associated water management designs.

CLOSURE

Please do not hesitate to contact Paul Weber at +64 27 294 5181 paul.weber@minewaste.com.au should you wish to discuss this in greater detail.

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ATTACHMENT A – WATER SAMPLING RESULTS

SampLe ID		MDD015	RSB	RS03
SampLe date and time		27/04/2023 11:30:00	27/04/2023 13:30:00	27/04/2023 14:53:00
Laboratory number	Units	817-2023-00038807	817-2023-00038808	817-2023-00038809
pH	pH units	8.2	-	7.4
Conductivity	mS/m	42.1	-	7.1
Suspended Solids	mg/L	10	-	<6
Total Non-Purgeable Organic Carbon	mg/L	0.1	-	2.2
Turbidity	NTU	0.44	-	0.31
Total Dissolved Solids	mg/L	206	-	35
Acidity to pH 8.3	mg $CaCO_3$/L	<1	-	<1
Acidity to pH 3.7	mg $CaCO_3$/L	<1	-	<1
Acidity to pH 7.0	mg $CaCO_3$/L	<1	-	<1
Total Alkalinity	mg $CaCO_3$/L	195	-	36
Total Hardness	mg $CaCO_3$/L	7	-	7
Fluoride	mg/L	0.19	-	0.07
Chloride	mg/L	10.1	-	1.47
Bromide	mg/L	0.09	-	<0.02
Sulfate	mg/L	16.5	-	1.07
Silica - Dissolved	mg/L	18.8	-	9.82
Dissolved (NP) Organic Carbon	mg/L	0.1	-	2.1
Cyanide	mg/L	<0.005	-	<0.005
Ammonia Nitrogen	mg/L	0.20	-	0.02
Nitrate-N	mg/L	<0.01	-	<0.01
Nitrite-N	mg/L	<0.01	-	<0.01
Total Nitrogen	mg/L	0.150	-	0.120
Total Phosphorus	mg/L	0.010	-	0.016
Dissolved Metals and metalloids				
Soluble Aluminium	mg/L	0.003	<0.002	0.006
Soluble Antimony	mg/L	<0.001	<0.001	<0.001
Soluble Arsenic	mg/L	0.036	0.142	0.009
Soluble Barium	mg/L	0.124	0.036	0.006
Soluble Beryllium	mg/L	<0.001	<0.001	<0.001
Soluble Bismuth	mg/L	<0.001	<0.001	<0.001
Soluble Boron	mg/L	0.04	<0.03	<0.03
Soluble Cadmium	mg/L	<0.0002	<0.0002	<0.0002
Soluble Calcium	mg/L	30.2	24.3	8.7
Soluble Chromium	mg/L	<0.001	<0.001	<0.001
Soluble Cobalt	mg/L	<0.0005	<0.0005	<0.0005
Soluble Copper	mg/L	<0.0005	<0.0005	<0.0005
Soluble Iron	mg/L	<0.01	1.01	0.07
Soluble Lead	mg/L	<0.0005	<0.0005	<0.0005
Soluble Lithium	mg/L	0.049	0.002	0.001
Soluble Magnesium	mg/L	16.7	5.38	1.90
Soluble Manganese	mg/L	0.0064	2.76	0.0170
Soluble Mercury	mg/L	<0.0005	<0.0005	<0.0005
Soluble Molybdenum	mg/L	0.0007	<0.0005	<0.0005
Soluble Nickel	mg/L	<0.0005	0.0007	<0.0005
Soluble Potassium	mg/L	1.58	1.76	0.51
Soluble Selenium	mg/L	<0.005	<0.005	<0.005
Soluble Silver	mg/L	<0.0005	<0.0005	<0.0005
Soluble Sodium	mg/L	36.8	8.06	4.58
Soluble Strontium	mg/L	8.45	0.327	0.105
Soluble Tin	mg/L	<0.0005	<0.0005	<0.0005
Soluble Titanium	mg/L	<0.0005	<0.0005	<0.0005
Soluble Thallium	mg/L	<0.0005	<0.0005	<0.0005
Soluble Uranium	mg/L	0.0012	<0.0002	<0.0002
Soluble Vanadium	mg/L	<0.0005	<0.0005	<0.0005
Soluble Zinc	mg/L	<0.002	<0.002	<0.002
Total Metals and metalloids				
Total Silicon	mg/L	7.43	6.49	3.64
Total Aluminium	mg/L	0.193	1.17	0.012
Total Antimony	mg/L	<0.002	<0.002	<0.002
Total Arsenic	mg/L	0.035	5.29	0.011
Total Barium	mg/L	0.146	0.130	0.005
Total Beryllium	mg/L	<0.005	<0.005	<0.005
Total Bismuth	mg/L	<0.005	<0.005	<0.005
Total Boron	mg/L	0.10	0.05	<0.05
Total Cadmium	mg/L	<0.001	<0.001	<0.001
Total Calcium	mg/L	31.5	29.6	8.2
Total Chromium	mg/L	<0.001	<0.001	<0.001
Total Cobalt	mg/L	<0.002	0.006	<0.002
Total Copper	mg/L	<0.002	0.002	<0.002
Total Iron	mg/L	0.3	86.5	0.1
Total Lead	mg/L	<0.001	0.003	<0.001
Total Lithium	mg/L	0.055	0.003	0.001
Total Magnesium	mg/L	17.7	5.3	1.7
Total Manganese	mg/L	0.009	4.40	0.019
Total Mercury	mg/L	<0.001	<0.001	<0.001
Total Molybdenum	mg/L	<0.001	<0.001	<0.001
Total Nickel	mg/L	<0.001	0.004	<0.001
Total Potassium	mg/L	1.4	2.7	0.5
Total Selenium	mg/L	<0.005	<0.005	<0.005
Total Silver	mg/L	<0.001	<0.001	<0.001
Total Sodium	mg/L	43.3	7.0	3.0
Total Strontium	mg/L	8.97	0.414	0.071
Total Tin	mg/L	<0.001	<0.001	<0.001
Total Titanium	mg/L	0.004	0.020	<0.001
Total Vanadium	mg/L	<0.001	0.002	<0.001
Total Zinc	mg/L	<0.005	0.079	<0.005

Notes

A hyphen (-) indicates that no data are available

ATTACHMENT B – ARCHAEOLOGICAL SITES

Site		Description	Arch Value
G41/604	CIT	Au mining. Turbine and battery	Med
G41/605	CIT	Au mining. Mine	Med
G41/586	CIT	Water race	Low
G41/589	Close to CIT	Revetted road	Low
G41/277	Pit footprint	Au mining. Rise and Shine battery and mine. Adits, slucing face, spoil, foundations, dam, stone faced terrace.	High
G41/603	Between Pit and Plant	Revetted road	Low
G41/588	Between Pit and Plant	European midden	Low
G41/587	Between Pit and Plant	Timber milling. Terraces	Low
G41/276	Plant site	Stone Chimney. Unclassified site type.	Med
G41/585	Plant site	Timber milling. Dam	Low
G41/670	Close to Plant site	Au mining. Tailings dam	Low
G41/669	Potential Shreks	Au mining. Mine working. Sluiced area	Low
G41/264	Potential Shreks	Au mining. Mine workings – water race, dam, adit, tailings, terrace, and sluice faces.	Med
G41/269	Potential Shreks	Au mining. Dam – 10 m wide	Med
G41/584	Between Shreks and Tailings	Water race	High
G41/251	On DOC land to West CIT No proposed impact	Au mining. Come in Time Battery. 10-stamper battery. 2 adits. Mullock. Track, wall and possible ore bins.	High

Source: Lawrence et al., 2019